Space Weather Technical Forecast

Issued on Sunday, 15 January 2023 at 01:27 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Further M-class flares and R1/R2 radio blackouts expected. Possible CME currently affecting the Earth.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Moderate over the last 24 hours, with three M-class flares observed. The first was from emerging region AR3191 on the eastern limb. Two further M-class flares were observed emanating from AR3182 in the southwest, the first a M3.5 at 14/2006UTC and a peak M4.6 flare at 14/2037UTC, both of these associated with a resulting CME. This region has developed a delta region, and with AR3184 and AR3186 forms one of three active regions with delta characteristics on the visible disc. These are also three of 13 classified solar regions on the visible disc, with the majority of these close to the eastern limb, where they are demonstrating increased complexity as they rotate across the limb. A number of weak alpha or beta regions are also evident on the solar disc. The CME which was observed leaving the vicinity of AR3182 around the time of the two M-class flares will be analysed once sufficient imagery becomes available, but the lift-off location suggests a possible Earth-directed component.

Solar Wind / Geomagnetic Activity: The solar wind at L1 declined from 500km/s to 400-450km/s through much of the period, with a slight increase at the end to just above 500km/s. Density was around average but increased to above average levels from around 14/1700UTC, reaching close to 11ppcc by 14/2359UTC. Interplanetary magnetic field strength, IMF, also showed a jump from mainly weak, to moderate levels, from around 14/1700UTC, reaching a peak of 12nT at 14/2355UTC. The north-south component was mainly positive until near to 14/1700UTC, but has been predominantly negative since that time, with a negative peak of -9nT at 14/2117UTC. All these changes suggest the arrival of a CME around 14/1700UTC, but the lack of geomagnetic activity suggests that this must be a weak feature. Phi angle has been consistently negative (towards the Sun). Geomagnetic activity started the period at Active levels, but has been Quiet to Unsettled through much of the day.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) as measured at GOES18 has been at background levels through the day. High energy electron flux (greater than 2 MeV) has varied between background to moderate levels on a diurnal cycle. The 24-hour integrated electron fluence stayed well below the Active threshold on a steady trend, reaching 3.3e6 integrated pfu by 14/2359UTC.

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Met Office Space Weather Technical Forecast

Four-Day Space Weather Forecast Summary
Solar Activity: Solar activity is expected to continue at Low to Moderate levels through the next four days, due to three large and magnetically complex regions on the visible disc. There are also a number of regions on the far east of the visible disc which could present an increasing risk during the forecast period. A chance of X-class flares is possible throughout.

Solar Wind / Geomagnetic Activity: A weak CME, perhaps from 11 January, appears to be affecting the Earth with continued effects probable through 15 January. A further CME left the southwest of the Sun on 14 January and may be forecast to affect the Earth during this period once a full analysis has been completed. Outside of CME influence, the solar wind is expected to be at mainly muted levels, but may increase on 17 January due to a connection with a weak high speed stream from coronal hole 65, with estimated speeds of 500km/s. Geomagnetic activity is forecast to be mainly Quiet, but with a risk of Active or G1/Minor Storms due to the CME effects.

Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux observed by GOES18 is likely to remain at predominantly background levels, but with a chance of enhancements which could produce an S1 or greater event through the period due to a number of magnetically complex sunspot regions on the visible disc. The high energy electron flux (greater than 2 MeV) is expected to continue at background to moderate levels, with the corresponding electron fluence remaining below the Active (1e8 integrated pfu) threshold.

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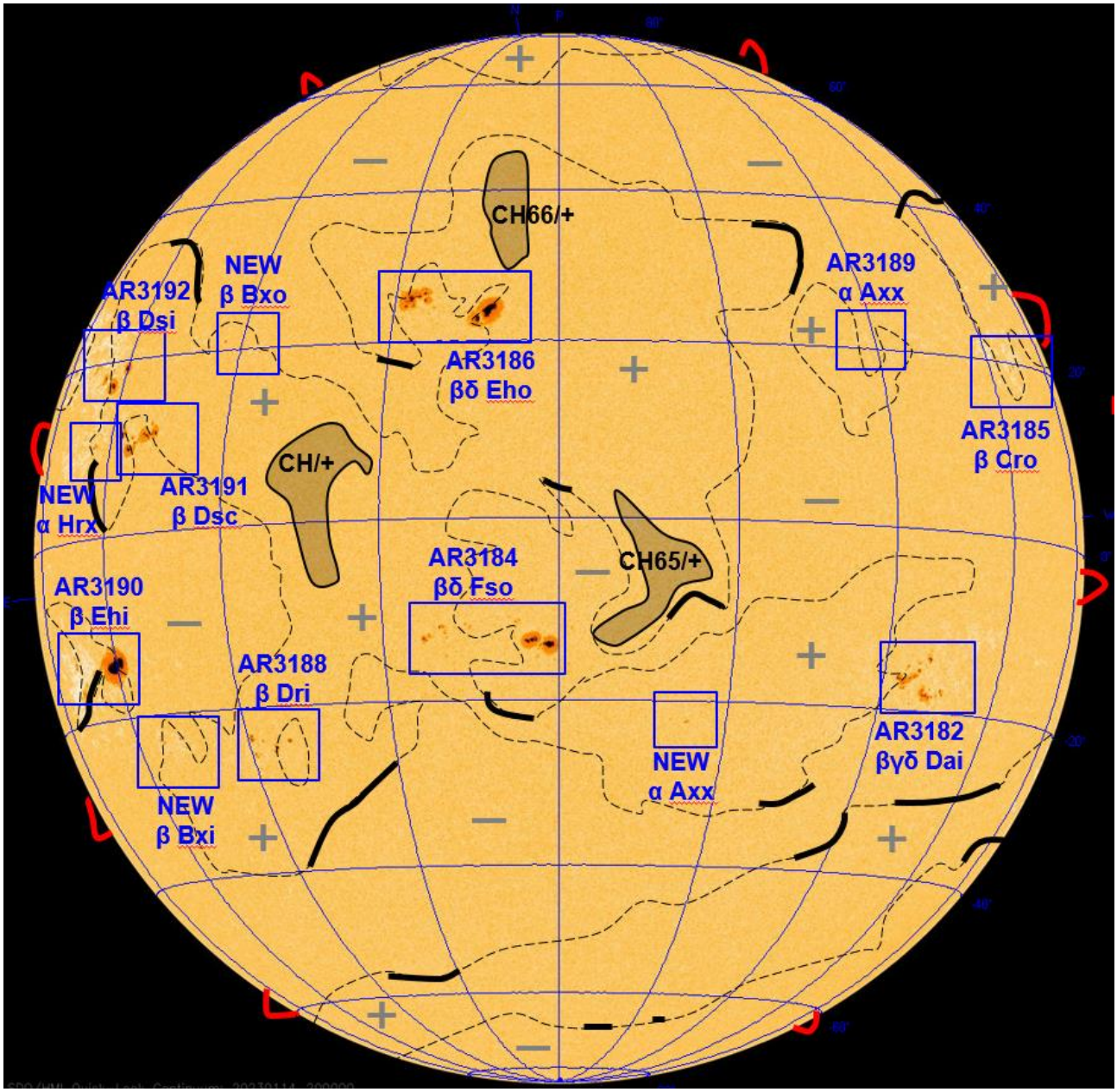
Figure 1. Solar Analysis Valid 14/2000UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

A CME appears to be currently affecting the Earth, with signatures at L1 suggesting a feature embedded in the solar wind. Although no feature is expected, there is a possibility that this is the feature which left the northwest of the Sun during 11 January as the analysis of this eruption was difficult with the result low confidence. A further CME has been emitted from the region of AR3182 in the southwest quadrant, with preliminary analysis suggesting that a partial halo CME is likely. Further analysis will be undertaken on this when sufficient imagery becomes available. Otherwise solar wind speeds are around 450-500km/s in under the influence of the transient CME. Although the period of time of elevated winds, as decline to background is likely through 15 and 16 January with no coronal hole high speed streams forecast. Based on a mid-range estimate of 500km/s, coronal hole 65 may connect with the Earth on 17 January, but given the apparent weakness of the feature, no significant activity is expected.

Geomagnetic activity is expected to be mainly Quiet, but with a slight chance of Active or G1/Minor Storms due to the continuing effects of the suspected CME on 15 January.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	10	1	1	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

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Figure 2: Recent solar wind observations at L1, with the changes mentioned in the text clearly evident.

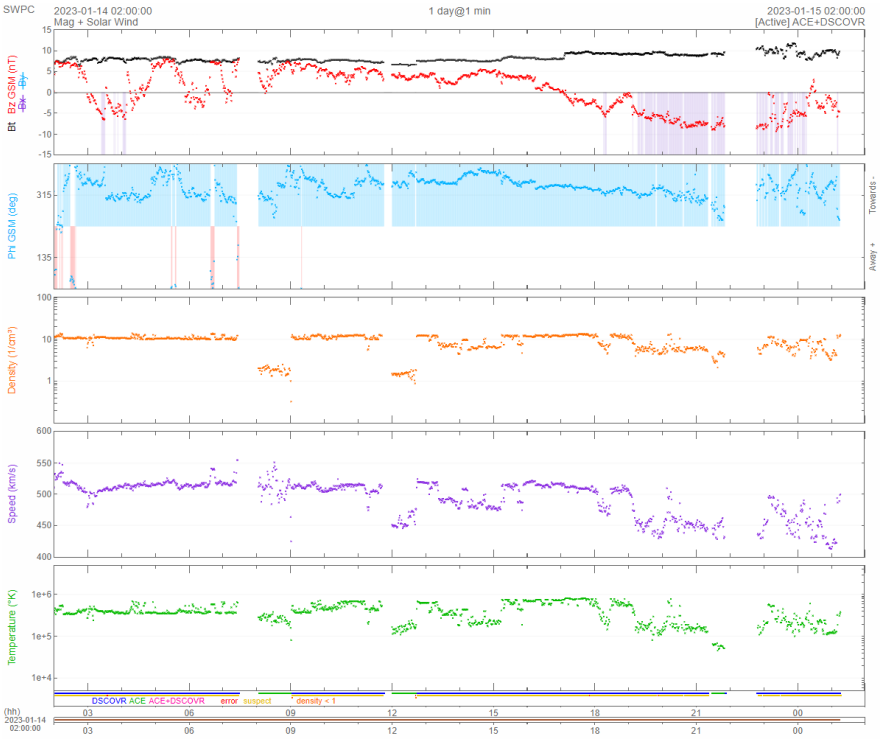
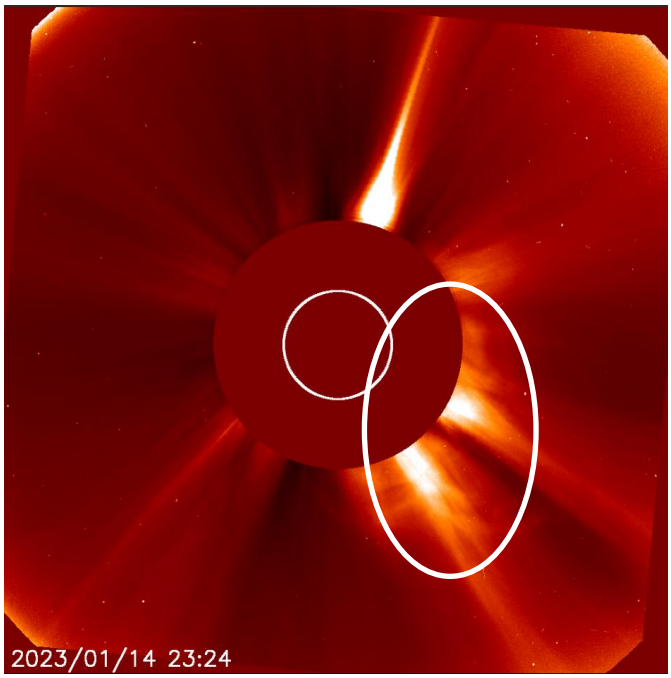


Figure 3: Emerging CME from AR3182 on SOHO LASCO C2 imagery



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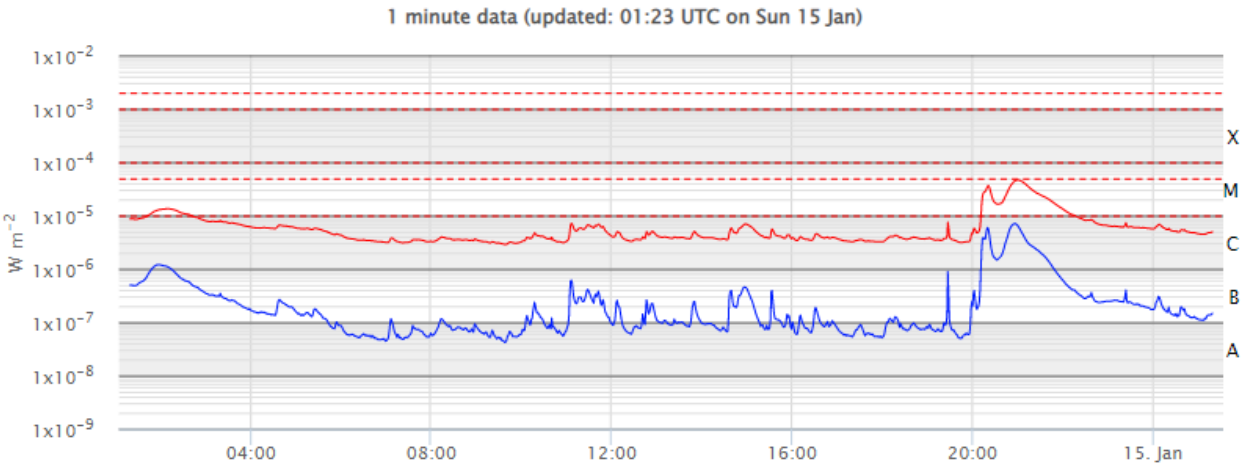
Radio Blackouts - X-Ray Flares:
Solar activity has been Moderate, with the evolution of a number of active regions on the visible disc. AR3182 has been the most active and appears to have produced a potential earth-directed CME following two M-class flares. This region has developed a delta region, with both AR3184 and AR3186 in the central disc both exhibiting delta characteristics. A number of regions are emerging on the eastern limb and while the magnetic complexity is difficult to analyse due to foreshortening effects, the configuration of these regions suggests a high flare risk.
Solar activity is expected to be at Low to Moderate levels, with much of the Moderate activity currently attributed to AR3182. There is also a daily risk of X-class flares, particularly from the three delta regions.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	80	80	80	70
Very Active	R3 to R5 X Class	No	20	20	20	15

Figure 4: GOES-18 X-ray flux



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Solar Radiation Storms - (High Energy Protons):

The high energy (greater than 10MeV) proton flux is currently at background.
There have been limited enhancements to proton flux at L1 with a continuing risk through the next four days, especially with a flare and CME from AR3181 giving rise to a low-energy proton increase at ACE. AR3184 and AR3186 are both demonstrating delta characteristics and will rotate into the western hemisphere through the forecast period, which is likely to result in an increased proton storm risk.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	30	40	40	40
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

High energy electron flux is oscillating between background and moderate levels as part of the normal diurnal variation. This may increase above the high (1e3 pfu) threshold later in the period as a result any inputs from the suspected CME on 16 January and also limited contributions from a weak high speed stream which may connect on 18 January.

Electron fluence is expected to remain below the Active threshold in the absence of significant inputs.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	1	5	10
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

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